DRAFT
GROUNDWATER INFORMATION SHEET

Methyl tertiary-butyl ether (MTBE)

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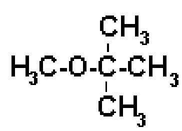
Revised:
October 23, 2002

The purpose of this groundwater information sheet is to provide general information regarding a specific constituent of concern (COC). The following information is pulled from a variety of sources and data relates mainly to drinking water. For additional information, the reader is encouraged to consult the references cited at the end of the information sheet.

GENERAL INFORMATION	
Constituent of Concern	Methyl tertiary-butyl ether (MTBE)
Aliases	2-Methoxy-2-Methyl Propane, Methyl 1,1-Dimethylethyl Ether
Chemical Formula	$C_5H_{12}O$ or more specifically $(CH_3)_3C\text{-}O\text{-}CH_3$ 
CAS No.	1634-04-4
Storet No.	46491, A-030
Summary	The California Department of Health Services (DHS) regulates MTBE as a drinking water contaminant. The current State Maximum Contaminant Levels (MCL) for MTBE, set by DHS, are 13 μg/L (primary MCL) and 5 μg/L (secondary MCL). The most prevalent use of MTBE is as a gasoline additive designed to create less combustion pollutant byproducts to address air quality regulations. Based on DHS data through 2000, 31 of approximately 16,000 public drinking water wells (active and standby status) have had concentrations of MTBE ≥ 5 μg/L, with most detections occurring in Los Angeles, San Bernardino and Kern Counties.

REGULATORY AND WATER QUALITY LEVELS[1]		
Type	**Agency**	**Concentration**
Federal MCL	US EPA, Region 9	N/A
State MCL (Primary) State MCL (Secondary)[2]	DHS	13 μg/L 5 μg/L
Detection Limit for Purposes of Reporting (DLR)	DHS	3 μg/L
Others: CA Public Health Goal (PHG) Cancer Potency Factor ($1/10^6$ cancer risk)	 OEHHA OEHHA	 13 μg/L 19 μg/L

[1]These levels generally relate to drinking water, other water quality levels may exist. For further information, see A Compilation of Water Quality Goals (Marshack, 2000).
[2]The Secondary MCL established by DHS addresses aesthetics associated with MTBE, while the Primary MCL addresses health concerns. Exceedance of either of the MCLs prompts certain regulatory requirements.

SUMMARY OF DETECTIONS IN PUBLIC DRINKING WATER WELLS[3]	
Detection Type	**Number of Groundwater Sources**
Number of active and standby public drinking water wells[4] with MTBE concentration ≥ 5μg/L.	34 of approximately 16,000
Top 3 Counties having public drinking water wells[4] with MTBE concentration ≥ 5 μg/L.	Kern, San Bernardino, Los Angeles
Top 3 Regions having public drinking water wells[4] with MTBE concentration ≥ 5 μg/L.	Central Valley, Los Angeles, Lahontan

[3]Based on DHS data collected from 1984-2000 (Geotracker). See Figures 1 and 2.
[4]In general, drinking water from active and standby wells is treated or blended so consumers are not exposed to water exceeding MCLs. Individual wells and wells for small water systems not regulated by DHS are not included in these figures.

ANALYTICAL INFORMATION		
Method	**Detection Limit**	**Note**
US EPA 524.2 or 8260	0.5 μg/L	Gas chromatography with mass spectrometer detector
US EPA 8020	0.05μg/L	Gas chromatography with photo-ionization detector

Known Limitations to Analytical Methods	EPA Method 8020 can detect MTBE but may yield false positives when other volatile organic compounds are present and co-elute in the same chromatographic range. The presence of MTBE must be confirmed prior to utilizing the Method 8020 for a long-term groundwater monitoring program. Due to the cost of Method 8260 analysis becoming more competitive with the Method 8020 over time, the ability of the Method 8260 to analyze samples for the full suite of gasoline range petroleum hydrocarbons, and the inability of Method 8020 to analyze some of the other required fuel oxygenates, Method 8260 has become the "standard" for fuel oxygenate analysis for groundwater samples.
Public Drinking Water Testing Requirements	Since 1997, when DHS' regulations identified MTBE as an unregulated chemical requiring monitoring, public water systems have analyzed their water for its presence and reported the results. As of February 4, 2002, DHS reported that 2,896 water systems have reported MTBE data. Those systems serve 31.1 million of the state's 34 million people, or about 91% of the population.

MTBE OCCURRENCE	
Anthropogenic Sources	The most prevalent use of MTBE today is as a gasoline additive to either raise the octane level or make the gasoline burn cleaner. MTBE has been introduced to unleaded gasoline at a proportion of approximately 11 to 15 percent of the total volume. The demand for MTBE as a fuel oxygenate has driven up production to over 200,000 barrels a day. As MTBE is replaced by ethanol, its production will gradually decline. The potential for a release of MTBE into the groundwater environment is present under the following scenarios: production and storage of MTBE, transportation of MTBE to refineries, the blending process at the refineries, transportation of reformulated gasoline to distribution points, or leaks from underground storage tanks and pipelines. Underground storage tank or piping releases make up the majority of the releases that have impacted groundwater. MTBE emissions to the atmosphere occur and the released MTBE can be deposited by precipitation to land and streams, which can eventually affect groundwater quality. Studies have shown that atmospheric deposition of MTBE usually only results in trace concentrations (low ppb) of MTBE detected in surface water, stormwater runoff, or shallow groundwater. In

	contrast, point sources of MTBE contamination are readily evident by the much larger concentrations of MTBE present in water. MTBE has been used as part of a treatment for gallstones.
Natural Sources	MTBE is a manufactured chemical that does not occur naturally in the environment.
History of Occurrence	MTBE has been used as a gasoline additive since the late 1970s. In August 1995, the City of Santa Monica discovered MTBE in drinking water supply wells at its Charnock Wellfield, Los Angeles, California. In August 1995, the City's Charnock Wellfield had five operating municipal supply wells which provided approximately 45% of the drinking water for the City's 87,000 residents and approximately 200,000 daytime customers. In 1996, levels of MTBE at the City's Charnock Wellfield increased to more than 600 parts per billion (ppb) (Well No. 19) and, by June 13, 1996, all of the supply wells at the City's Charnock Wellfield were shut down due to persistent and increasing levels of MTBE contamination. In October 1996, following the shutdown of the City's Charnock Wellfield, the Southern California Water Company ("SCWC"), another water purveyor utilizing the Charnock Sub-Basin, shut down its wellfield in the sub-basin, in order to avoid drawing the contamination toward the SCWC Wellfield. Enforcement orders from U.S.EPA and the Los Angeles Regional Water Quality Control Board required a total of 16 responsible parties to provide water replacement for the impacted service areas until January 2005, a significant expense. At the same time that the problems in Santa Monica were occurring, several public supply wells in South Lake Tahoe were found to be impacted by MTBE. As of the winter of 2001, the South Tahoe Public Utility District has taken 12 of the District's 34 drinking water wells off-line due to the presence of MTBE in nearby plumes or, in 8 of the cases, because MTBE had reached the wells. The wells that have been taken off-line represent 35% of the District's wells, 3.4 million gallons per day lost production capacity, and 27% potential water production. DHS reports that as of July 6, 2001, MTBE has been detected in 44 (1.9%) of 2,350 public water systems that have been

	sampled in the state. Over half of those 44 public water systems (24, or 1.0 % of the total), had MTBE detection above the Secondary MCL, and 13 public water systems had detections of MTBE at concentrations above the Primary MCL. MTBE has also been detected in significant concentrations in domestic and small well systems in many parts of the state. These wells are not regulated by DHS and are not regularly monitored.
Contaminant Transport Characteristics	Two physiochemical characteristics of MTBE are the primary reasons that MTBE poses such a significant threat to groundwater resources. The first characteristic is the high solubility of MTBE in water. This strong affinity of MTBE to partition to, and exist in, the dissolved phase, tends to result in rapid leaching through the unsaturated zone to groundwater, poor sorption to sediments and organic material, and the ability of MTBE to migrate within the saturated zone at nearly the velocity of the groundwater flow itself. The second significant physiochemical characteristic of MTBE is its relative resistance to biological degradation in the subsurface. Research has suggested that MTBE can be degraded by certain bacterial strains under strongly oxic conditions. The MTBE molecules are structured such that bacteria will preferentially degrade other more easily metabolized hydrocarbons first (conditions likely to be present in the anoxic source zones of gasoline releases). At the aerobic fringes of petroleum hydrocarbon plumes, MTBE may be biologically degraded, which would help explain why there are not more extremely large MTBE groundwater plumes in existence. In cases where biologic degradation occurs, toxic degradation daughter products such as tertiary-butyl alcohol (TBA) and tertiary-butyl formate (TBF) can be generated. As these factors indicate, MTBE is relatively mobile and persistent in the subsurface, compared with other gasoline-range petroleum hydrocarbons. Hence, MTBE has the potential to impact a greater volume of groundwater in the area of a given release, and the vulnerability of a supply well to an MTBE impact is heightened when MTBE is present in groundwater within its hydraulic capture zone.

REMEDIATION & TREATMENT TECHNOLOGIES

There are several remediation technologies available to remove MTBE effectively and efficiently from soil and groundwater. These include:

Soil Vapor Extraction (SVE) – SVE is effective on MTBE in the unsaturated zone due to the high vapor pressure of MTBE. The MTBE is more difficult to remove when in the dissolved phase.

Air Sparging - MTBE can be removed from groundwater by air sparging. Due to high solubility of MTBE, it may take a greater volume of sparged air to volatize the MTBE from the groundwater (as opposed to other gasoline constituents). The pumping or air through the groundwater may also oxygenate the groundwater and stimulate biodegradation of dissolved contaminants. Air sparging must be used in conjunction with soil vapor extraction to remove the MTBE from the subsurface.

In-situ Oxidation - In-situ oxidation relies on the capacity of certain chemicals (e.g. hydrogen peroxide combined with iron) to rapidly oxidize organic molecules in water, such as MTBE.

Bioremediation - MTBE is generally slower to biodegrade under natural conditions than other gasoline constituents. However, recent field studies have shown that under enhanced conditions (e.g., addition of oxygen, microbes, and/or nutrients to the soil and groundwater), MTBE will biodegrade more rapidly.

Flushing (Pump and Treat) - This technology consists of pumping contaminated groundwater to the surface and treating it using air stripping, activated carbon, or advanced oxidation. The high solubility of MTBE and low soil adsorbency allows MTBE to be readily flushed from the aquifer.

For treatment of drinking water, the most commonly used treatment techniques are air stripping, carbon adsorption, and advanced oxidation (oxidation of contaminants using appropriate combinations of ultraviolet light, chemical oxidants, and catalysts).

In addition to the established technologies discussed above, there are many other emerging technologies for the remediation and treatment of MTBE, including bioaugmentation, synthetic resin adsorbents, electron beam oxidation, and fluidized bioreactors.

HEALTH EFFECT INFORMATION

Breathing small amounts of MTBE for short periods may cause nose and throat irritation. There are no data available on the effects in humans of ingesting MTBE. Studies with rats and mice suggest that ingesting MTBE may cause gastrointestinal irritation, liver and kidney damage, and nervous system effects.

There is no evidence that MTBE causes cancer in humans, although animal studies have found that breathing high levels of MTBE for long periods may cause kidney or liver cancer.

KEY REFERENCES

1. California Department of Health Services. *Drinking Water Monitoring for MTBE.* http://www.dhs.ca.gov/ps/ddwem/chemicals/MTBE/MTBEindex.htm. (Oct. 23, 2002)

2. California Environmental Protection Agency / Regional Water Quality Control Board, Central Valley Region. August 2000. *A Compilation of Water Quality Goals*. Prepared by Jon B. Marshack. http://www.swrcb.ca.gov/rwqcb5/available_documents/wq_goals/wq_goals.pdf

3. California Environmental Protection Agency / Office of Environmental Health Hazard Assessment . March 1999. *Public Health Goal for Methyl Tertiary Butyl Ether (MTBE) in Drinking Water.* http://www.oehha.ca.gov/water/phg/pdf/MTBE_f.pdf

4. South Tahoe Public Utilities District. *Tahoe MTBE Facts.* http://tahoe.ceres.ca.gov/stpud/faqsMTBE.html (Sept. 2002)

5. The National Environmental Education and Training Foundation (NEETF). What's In The Water – NEETF's Guide to Consumer Confidence Reports on Drinking Water Quality. *MTBE.* http://www.waterqualityreports.org/waterquality/definitions/MTBE.htm (Oct. 23, 2002)

6. Oxygenated Fuels Association. *The Facts on Managing MTBE-Blended Gasoline Releases to Water Supplies.* http://www.ofa.net/content2.htm (Oct. 23, 2002)

7. U.S. Environmental Protection Agency. Underground Storage Tanks. *MTBE (methyl tertiary-butyl ether) and Underground Storage Tanks.* http://www.epa.gov/oust/MTBE/index.htm (Oct. 23, 2002)

FOR MORE INFORMATION, CONTACT:
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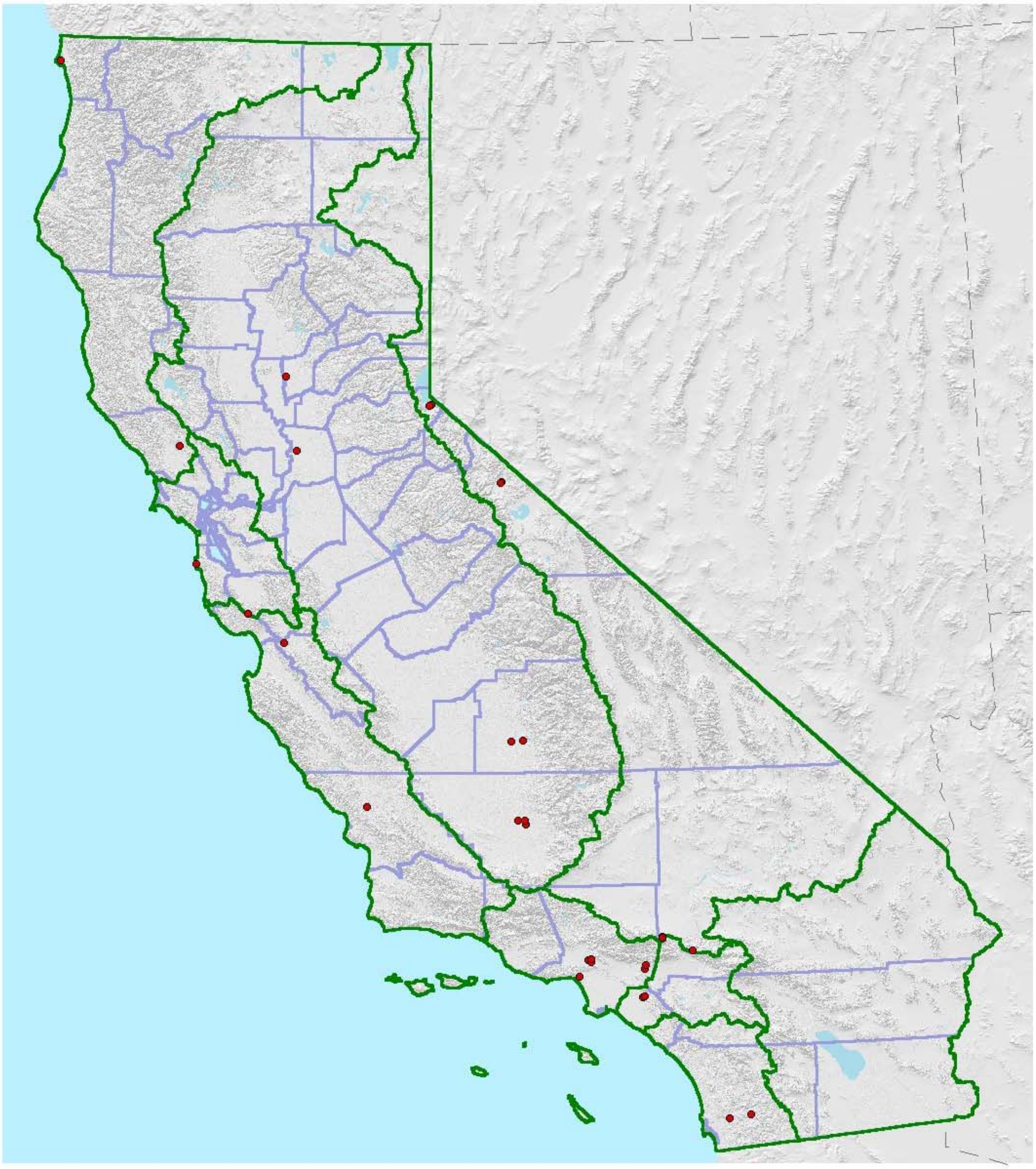
Groundwater Information Sheet: MtBE
Figure 1



Active and Standby DHS Wells (31 Total) with at Least One Detection of MtBE >= 5 PPB MCL

Source: 1984 - 2000 DHS Data (Map Revised 10/02/02)

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Groundwater Information Sheet: MtBE
Figure 2

Abandoned, Destroyed, and Inactive DHS Wells (10 Total) with at Least One Detection of MtBE >= 5 PPB MCL

Source: 1984 - 2000 DHS Data (Map Revised 10/02/02)
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